2006-2007 Academic Year Competition

Fundamental Aeronautics: Challenges and Opportunities

Part of NASA's mission is to inspire the next generation of engineers, scientists, and explorers. This year, the competition offers college students an opportunity to try to solve some of the technical challenges facing real aeronautics projects. Technical challenges exist in four areas: Hypersonic flight, Supersonic flight, Subsonic Fixed Wing transport, and Subsonic Rotary Wing transport. Some of these challenges occur in Earth's atmosphere, others occur in space. To solve these complex problems, real world teams from public and private sectors collaborate. In the college competition, challenges may be more thoroughly examined by multi-disciplinary, multi-department teams. Where possible, such teams are encouraged.

Categories for entry:

Individual undergraduate students or a small team (10 or fewer): Write a well documented concise paper that explains your design for a system that addresses at least one of the technical challenges (see below). Teams must have a student leader and at least one faculty advisor.

Larger team of undergraduate students (more than 10 students) and/or graduate students: Write a well documented concise paper that explains your design for a system that addresses at least one of the technical challenges (see below) **AND** integrates all the necessary elements for a new transportation concept. Combination teams with undergraduates and graduates are permitted. Teams must have a student leader and at least one faculty advisor.

For graduate students: Multi-disciplinary Design, Analysis and Optimization. Write a concise paper that communicates your validated ideas for analysis tools. The creation of practical designs depends on understanding and exploiting the interactions among all of the technology challenges. This requires the development of a flexible integration framework where variable fidelity analysis tools can be used in a *plug and play* fashion as determined by the type of problem examined. Teams must have a student leader and at least one faculty advisor.

Note: Reference documents for each of the four fundamental aeronautics projects can be found at http://aerospace.nasa.gov/programs_fap.htm

*Paper for all categories is limited to a 25-page report (page limit excludes ancillary material, references, and appendices).

Technical Challenges:

Innovative Configurations for High Mass Martian Landing

Designs are needed for innovative entry descent and landing (EDL) systems to enable the landing of Martian exploration systems with up to a two order of magnitude increase in mass compared to recent landers. These systems must be landed with much greater position accuracy as well. The new systems must address the key elements of EDL including hypersonic reentry and deceleration, supersonic deceleration, subsonic terminal deceleration and precision landing.

Hypersonic Flight

Innovative hot structure attachment concepts: Innovative methods and materials are required to attach hot structure (typically 3000F) to inner structure that must be no hotter than 250-350F. The structural concept must efficiently transfer mechanical load without transferring heat load and do so at low weight and cost.

Efficient shapes for access to space: Innovative shapes are required to improve the efficiency of air breathing vehicles for access to space.

Supersonic Flight

Supersonic Cruise Efficiency: To achieve economic viability, supersonic cruise civil aircraft need to demonstrate unprecedented levels of cruise efficiency, without excessively penalizing performance in other speed regimes. Cruise efficiency, including airframe and propulsion efficiency, needs to be increased by a combined total of approximately 30% in order to provide the required supersonic cruise range.

Materials that are Light Weight and Durable at High Temperature: Significant reduction in high temperature airframe and propulsion system weight is a key element to achieving practical supersonic flight. New material and structural systems must achieve these weight targets without affecting life or damage tolerance. Overall, a reduction on the order of 20% of structural and propulsion system weight is required.

Sonic Boom: In order to achieve maximum utility, supersonic overland flight must be achievable. This requires that the aircraft must be designed and operated so that no unacceptably loud sonic boom noise is created over populations. It is estimated that a reduction of loudness on the order of 30 PLdB relative to typical military aircraft sonic booms will be required.

Subsonic Fixed Wing Transport

Design a short take off and land commercial transport system that can carry 125-150 passengers a distance of 500 nmi at M=0.8 or better using 2500 foot runways. Also included in the design should be technology designed to do one or more of the following:

- lower noise levels (stage 3 -52db cum)
- lower landing-take-off nitrous oxide emissions (80 percent reduction from 1996 ICAO standard)
- improve cruise performance (using 25 percent less fuel than current transports of the same size)

Subsonic Rotary Wing Transport

Highly Reliable and Efficient Rotorcraft Propulsion: Design a modular rotorcraft for commercial passenger transport (airliner style) that would permit on-the-tarmac servicing. For example, the modularity could enable swap-out of the primary drive-train with minimum tooling and lift equipment, allowing for off-line servicing without disrupting aircraft availability.

Noise Reduction from Improved Understanding of Rotorcraft Acoustics: Design an advanced helicopter (as compared to current helicopters) specifically tailored to maximize noise reduction from a systemic perspective.

Improved Operating Environment from Advancements in Rotorcraft Structures and Materials: Design advanced crashworthiness and survivability systems for civilian medical evacuation helicopters.

Innovations from Improved Understanding of Rotorcraft Aeromechanics and Fluid Dynamics
Examples of what these innovations might enable:

- Viable design of a large commercial V-22-like tiltrotor aircraft. Address vehicle performance in terms of passenger capability, range, cruise speed, etc. Analyze and discuss design trades leading to the final design. Identify critical innovations to resolve aeromechanics technologies/issues.

- Urban evacuation. What innovations would enable a significant evacuation/rescue capability from urban centers during natural and manmade disasters? For example, students could design something to overcome the challenges faced in the post-Katrina rescue effort.